Table 3: Summary of Bulk analysis results: Comparison of EU and UK laboratories

Participant Category	Number of Laboratories	Number of non-critical errors	Number of critical errors	Number of super-critical errors	Average error score
EU Labs	24	17	3	0	3.2
UK Labs	44	31	9	0	3.4
All	68	48	12	0	3.4

Both sets of laboratories performed well, with a low number of errors which showed that the identification method worked well.

5.2 Semi-quantitative light microscopy screening method

This method is outlined in figures 5 & 6 and appears in full as annexe 3 and was the focus of the EU project. After identifying asbestos in the bulk substance or material, the method seeks to quantify the mass of possible asbestos fibres by PLM/PCM microscopy analysis. For amphibole asbestos containing materials a standard challenge is introduced of repeated 1 minute grinding of a representative 0.5 - 1 g sample in a ceramic mortar and pestle until all the material passes through a 140 mesh (106 µm hole) woven wire sieve mesh. Representative aliquots are then taken from a sedimented suspension of these fines and filtered onto cellulose ester membrane filters which are dried and collapsed onto glass microscope slides for PCM/PLM analysis. Fibres of asbestos are discriminated using birefringence and extinction angle (fibres below 0.8 µm width are assumed to be asbestos). Much of the projects work into developing the method for sample preparation was carried out by the other laboratories. HSL's role was to fully participate in all discussions and reviews to develop the methodology, to comment on the drafts and carry out inter-laboratory tests. Six drafts were produced for detailed comment and appraisal.

The aim of the method was to measure the mass percentage of asbestos to within a factor of 2 (-50% to 200%) of the accurate result, to a probability of 90%. The protocol and results for the inter-laboratory trials carried out to see whether this aim was achieved are described in full in appendix 6 and summarised briefly here. Intra-laboratory trials using two experienced counters achieved this target. The inter-laboratory tests were conducted in two rounds with 15 of the 24 participating laboratories returning results. The first round consisted of counting two prepared slides. Round 2 required five samples to be analysed from the bulk material supplied. Summary results from rounds 1 (13 laboratories) and 2 (15 laboratories) are given in figure 7a with the performance of HSL (Lab 13) identified by the filled symbols. The samples were mixed with weighed amounts of asbestos being added so the mass

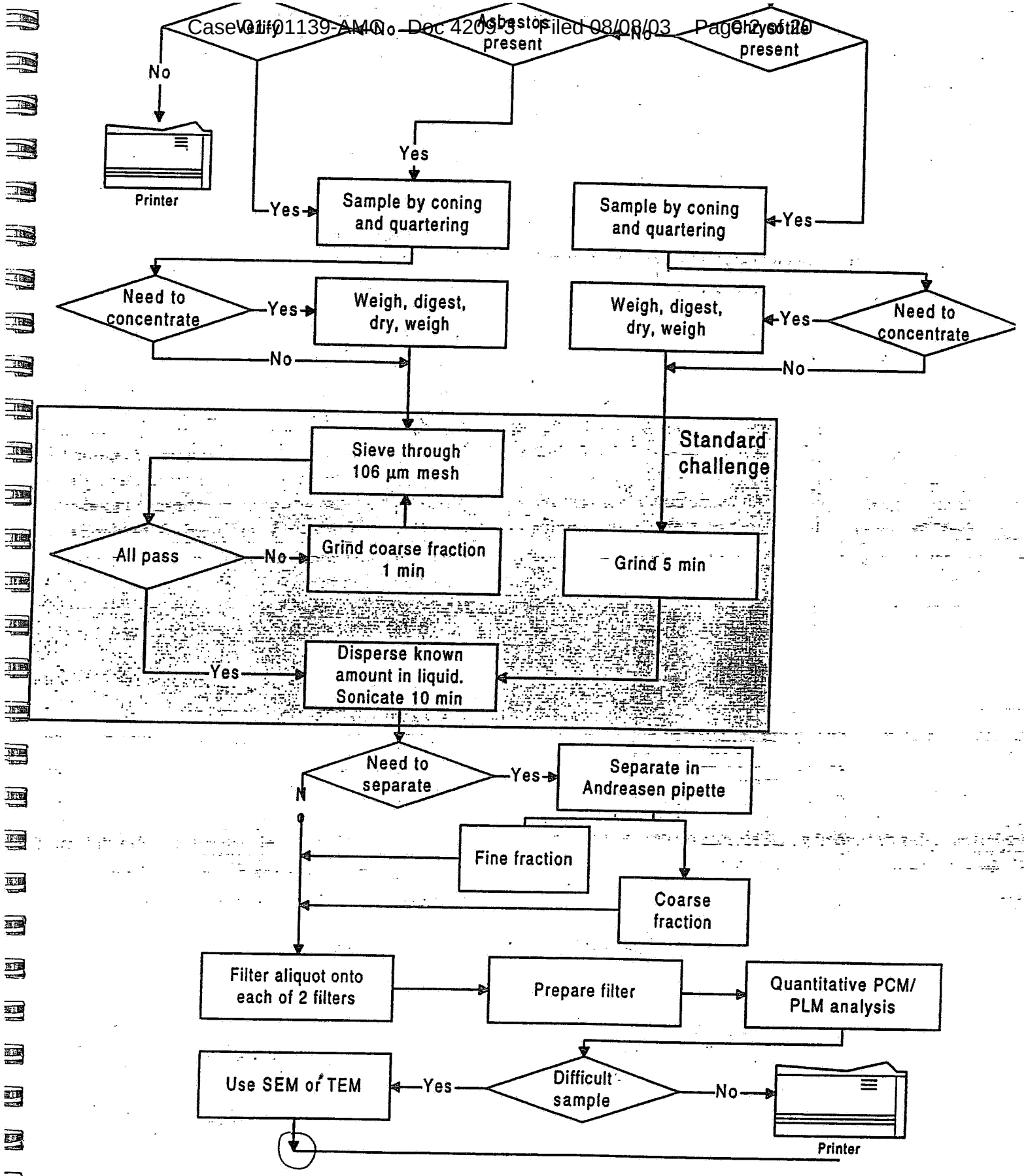


Figure 5: Preparation of samples for PCM/PLM analysis

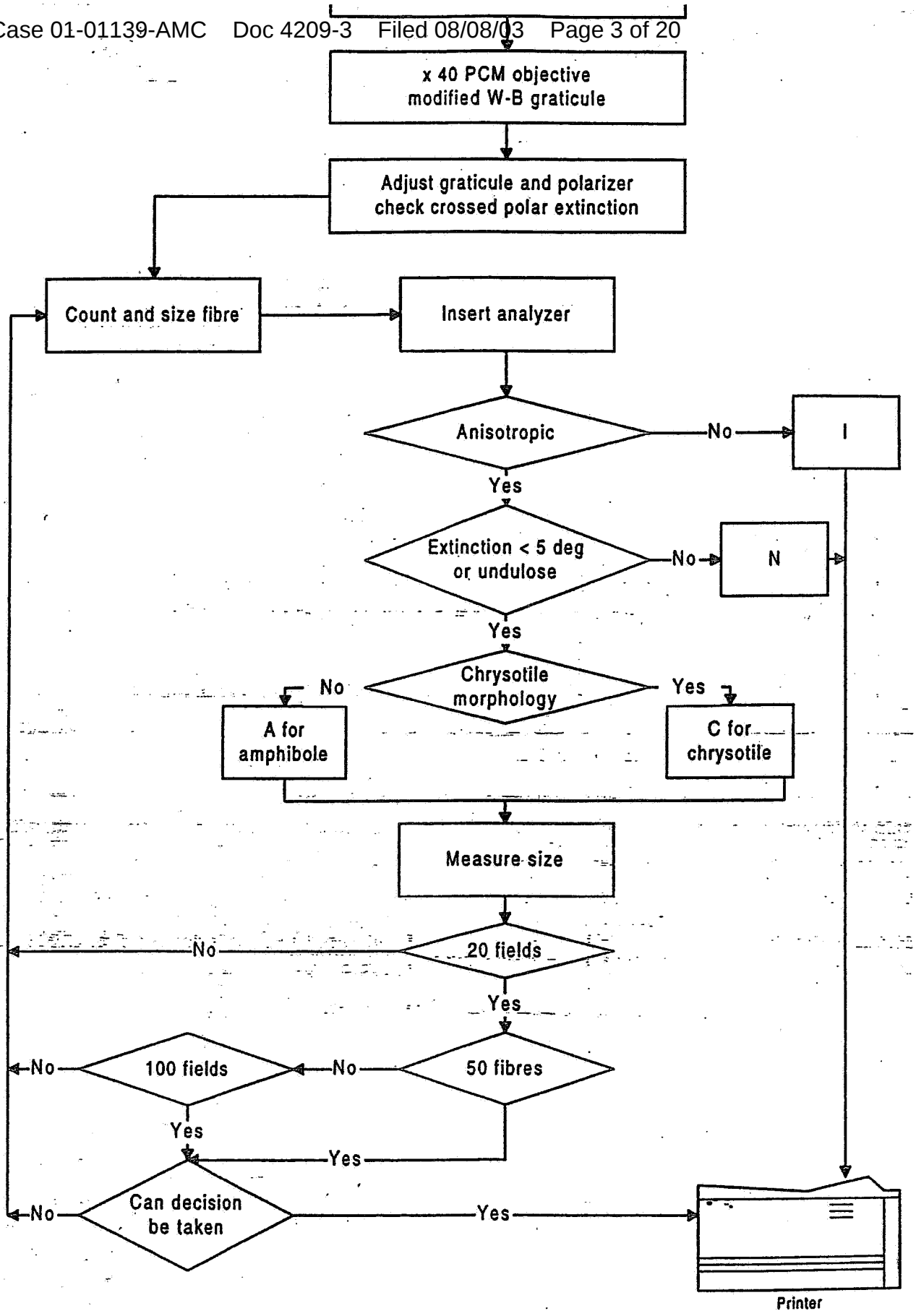


Figure 6: PCM/PLM fibre assessment flow diagram

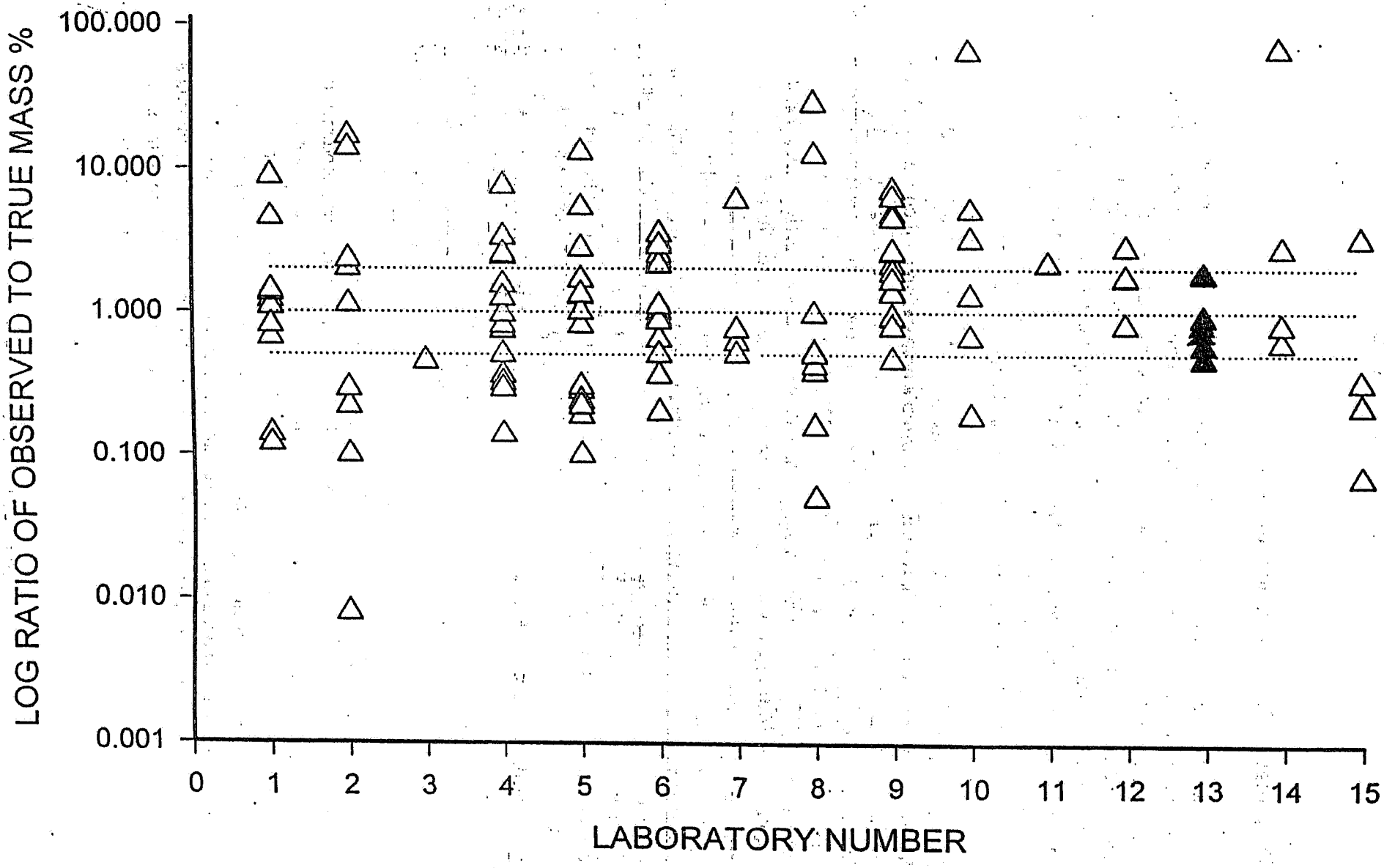


Figure: 7b. Ratio of observed to nominal mass % for PCM/PLM analysis: Interlaboratory comparison results, rounds 1&2

percentage was accurately known. There was a large amount of scatter between laboratories showing that it was quite a difficult method to apply and more experience with the method was necessary to establish the precision.

5.3 Quantitative TEM reference method

This method was designed to extend the semi-quantitative light microscopy by quantifying the fibres present on the final filter preparation in a transmission electron microscope (TEM) fitted with an energy dispersive x-ray analysis (EDXA) and selective area electron diffraction (SAED) to identify the fibres seen by their chemistry and crystallography. The method was compatible with the existing ISO ambient air method for asbestos analysis (ISO 10312:95), and all asbestos fibres >0.5 µm long were sized, counted and identified in a known number of grid openings and the mass calculated from the fibre dimensions and density.

Inter-laboratory comparison of the method was limited as HSL was the only EU laboratory carrying out the analysis and the sample preparation method was dependent on the procedures being developed for the light microscopy method, which were under development and subject to change almost to the end of the EU project. This meant that we could only test the TEM ISO 10312:95 analysis against other laboratories. An international exchange was arranged with one US (MVA Inc.) and one Canadian laboratory (Chatfield Environmental). The HSL results from the inter-laboratory exchange are summarised in figure 7b and given in more detail in appendix 7. The current limits for acceptability from the UK RICE (regular interlaboratory counting exchange) for PCM fibre counting were used to compare the precision of the fibre counting / identification results. The two sets of lines in figure 7b represent the upper and lower limits of bands 1 & 2 (acceptable) performance. It can be seen that HSL counts were close to a group mean showing the fibre counting and analysis procedures employed for the TEM are in good control and relatively precise.

In the second part of the assessment, the TEM method was used to analyse a set of laboratory prepared samples. All but one of the samples were prepared by adding known weights of asbestos to a known weight of matrix , so the accuracy of the mass result can be determined. These results obtained are compared in table 4 and show that although reasonable accuracy in terms of mass was obtained (after applying a K = 0.3 to account for overestimation of amphibole fibre depth) there was a tendency to overestimate. The TEM evaluation included all fibres >0.5µm long and these have relatively little mass compared to larger fibres. The TEM method must also concentrate on the larger fibres to obtain a more precise mass measurement, and a stratified method will need to be used, scanning a large area of filter at low magnifications to find the contribution of the largest few fibres as well as counting a few random grid openings for all fibres, to gain a more precise estimate of the size distribution and mass percentage. Nevertheless, values were within a factor of 3.

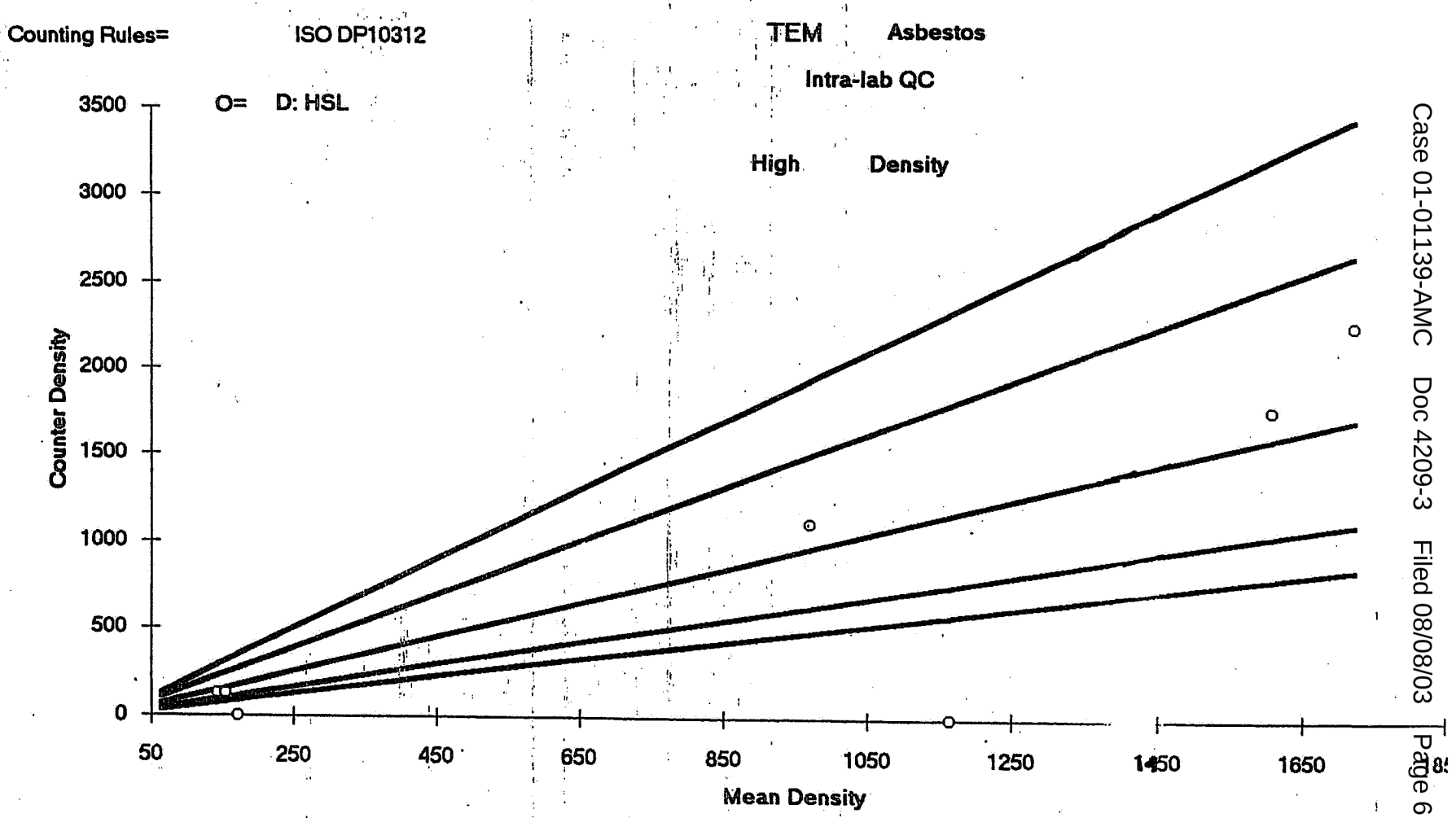


Figure 7b: Results of a TEM interlaboratory comparison of asbestos by ISO 10312:95

Table 4: Summary of TEM analysis results: Comparison to added asbestos.

Sample Number	Added amount of asbestos to matrix	Target lower and upper range (-50% - +200%)	TEM value reported for asbestos fibre mass percentage	Within specified range
1	~20% Anthophyllite + tremolite	10 - 40	20.2	yes
5.2.9	1% Amosite	0.5 - 2.0	2.6	no (x2.6 high)
7.2.9	0.05% Tremolite	0.025 - 0.1	0.05	yes
8.2.6	0.25% Amosite	0.12 - 0.5	0.5	yes
9.2.8	0.01% Chrysotile	0.005 - 0.02	0.03	no (x3 high)

5.4 Success of method development

Both the PLM identification method and the PCM/PLM semi-quantitative method were drafted in international or European standard format and circulated several times for comments among 24 interested laboratories. Both methods have undergone reasonably successful international inter-laboratory trials using well - characterised or precisely made spiked samples to measure the accuracy. Therefore these methods have been validated. The TEM method has also been drafted in ISO format and partially tested in an international interlaboratory exchange.

6. CASE STUDIES

The protocols developed, or early versions of then, have been applied by HSL to a number of interesting samples.

6.1 Northern European dolomites

Tremolite is an early product of the thermal metamorphism of dolomite (calcium magnesium carbonate) containing silica impurities. Its formation occurs by a reaction of the dolomite and quartz since the Ca:Mg ratio is greater in dolomite than tremolite calcite (calcium carbonate) is also formed. The geological conditions in some European dolomites favoured the formation of tremolitic fibres, whose presence led to some occupational health concern which provided some of the impetus for the

EU work. A study of these materials was carried out was used to explore the advantages and disadvantages of the methods developed.

6.1.1 Macroscopic examination and formation

A sample of rock from the dolomite deposit being studied was obtained and is shown in plate 9. The tremolite fibres had distinct parallel orientation along a relatively narrow slip plane. The fibres were not easily separable in all the deposit suggesting a columnar form, although in some areas fibre bundles could be picked out. This suggested that the fibres likely to be encountered when the sample was comminuted would have a range of morphologies.

6.1.2 Sample preparation

The dolomite from this deposit is mined for use as an industrial filler and whitener and is crushed and sieved to give a range of sizes. Nine of the sieved grades were sampled and further sub-samples were prepared for PCM/PLM and TEM analysis to measure the mass of asbestos. An earlier version of the methods was used. The purpose of the work was to establish whether tremolite asbestos fibres contaminated the dolomite above or below the 0.1% level. The finest samples had been sieved to <10 µm so had already received a substantial challenge, which would be capable of releasing elongated cleavage fragments and asbestos fibres. However the range of samples sizes extended to 3 - 5 mm so these samples were ground to a diameter of 50 µm in a single pass Glen Creston mill before additional 1 minute grinding in a McCrone micronising mill. A sub-sample was weighed out and dried to constant weight and acid washed to remove the dolomite to concentrate the analyte. The residue was resuspended in 500 ml of water and thoroughly mixed before an aliquot was extracted and filtered onto a 0.2 µm cellulose ester filter, which was prepared for both optical and TEM evaluation.

6.1.3 PCM/PLM Optical microscopy examination

The filters were examined using x500 PCM/PLM microscopy to count and roughly size the fibre of >3:1 aspect ratio to the nearest 0.5 µm. Relatively low aspect ratio fibres were seen (Plate 14). The fibres seen were viewed under cross polars and the stage rotated to confirm extinction and the angle measured. For an initial estimate any fibres showing extinction angles < 10 degrees were assumed to be asbestos and/or twinned fibres.

To assess the hazard all > 5µm long fibres were counted and sized but a half fibre weighting was applied to fibres with only one end in the Walton - Beckett graticule. The size distribution data are given in table 5. The mean fibre widths ranged from 1.6 - 3.2 µm and aspect ratios from 7.5 -12.3 µm. Mass analysis (table 6) gave a range of concentrations ranging from 0.3 - 12.89 % with most of the mass present in one or two large fibres / cleavage fragments.

Plate 14 Examples of dolomite materials as seen by phase contrast microscopy (approximate area 600 x 460 μm).

Sample HSL/82668/95 (0-100μm)

Plate 15 Examples of dolomite materials as seen by transmission electron microscopy.

Although these were unlikely to be asbestos they could not be excluded from the hazard assessment, without additional information. In later work detailed measurements of the cross section of tremolite fibres showed that the preferred orientation of the fibres on the filter gave an overestimate of fibre volume and mass if width ^{2} was used in the calculation. The actual cross-section approximated to an irregular hexagon due to the preferred cleavage on the (110) and (100). This correction factor is not precise but is of the order of 0.4 - 0.5. Therefore the screening method gave estimates consistently in excess of 0.1%.

If the samples were made airborne only fibres with widths < 3µm would be respirable, therefore the mass of asbestos contributing to the risk was also estimated. The range of values extended from 0.03 - 0.44% with 5 samples above 0.1%. It could be argued that a sufficient grinding took place to give an estimate of the maximum potential for respirable fibre and if the overestimate from the cross section is taken into account only one sample gave a fibre concentration > 0.1%. For repeat analysis on the same sample by different counters the precision was usually within a factor of two of the original count.

TABLE: 5 Mean fibre width and aspect ratio for PCM/PLM analysis for N. European dolomites.

Material Particle size (µm)	Sample number	Mean Fibre Width (µm)	Mean aspect ratio
0-10	HSL/82668/95	1.67	7.5
0 - 20	HSL/82669/95	1.9	12.3
0 - 30	HSL/82667/95	2.5	7.6
0 - 74	HSL/82670/95	2.9	10
0 - 125	HSL/82671/95	1.9	12.3
0 - 150	HSL/82672/95	3.23	12.1
0 - 250	HSL/82673/95	1.6	12.3
1 - 1500	HSL/82674/95	2.43	11.6
3000 - 5000	HSL/82575/95	2.24	10.3

Table 6: Summary of optical microscopy evaluations of dolomites to determine mass percentage in matrix.

		% Mass of fibres in matrix				
Sample number	Particle Size (um)	All fibres	Fibres with <10° ext.	Fibres with <10° ext. and half fibre weighting	Fibres <3um width	Fibres <3um width, with <10° ext. and half fibre weighting
HSL/82668/95	0 -10	2.84	1.57	1.38	0.72	0.44
HSL/82669/95	0 - 20	1.09	0.64	0.6	0.19	0.15
HSL/82667/95	0 -30	7.22	2	1.55	0.14	0.07
HSL/82670/95	0 -74	4.33	1.09	1.07	0.16	0.15
HSL/82671/95	0 -125	25.9	25.74	12.89	0.06	0.02
HSL/82672/95	0 - 150	4.42	1.73	1.5	0.06	0.05
HSL/82673/95	0 -250	0.62	0.49	0.3	0.05	0.03
HSL/82674/95	1 - 1500	2.88	2.76	2.59	0.14	0.11
HSL/82575/95	3000 - 5000	22.62	20.93	10.65	0.24	0.14
HSL/82566/95	blank	0.01	0.01	0.01	0	0
HSL/82674/95R	1 - 1500	2.65	0.85	0.71	0.09	0.06

6.1.4 TEM analysis of dolomite samples

One sample (0 - 30μm) was prepared for TEM analysis with and without acid digestion (30% HCl) using the methods described in annexe 3. The TEM results given in Tables 7 a and 7b, include the measured fibre mass and the calculated fibre mass percentage in the sample for the following fibre sizes:

(i) all fibres >0.5 μm long with a >3:1 aspect ratio.

(ii) >5μm long fibres with a >3:1 aspect ratio.

(iii) all fibres >0.5 μm long with a >3:1 aspect ratio and width <3 μm.

(iv) >5 um long fibres with a >3:1 aspect ratio and width <3 μm.

The first two represent a hazard and the last two the risk if the dust was made airborne. It can be seen in tables 7a & 7b, values of 6.2% and 0.32 % by mass were obtained as measures of the hazard and risk, for the >5 um long tremolite fibres. The figures from the PCM/PLM analysis were 7.22% and 0.14% for the same size of fibres before discrimination using extinction angle was applied and 1.5 and 0.07 % after discrimination and adjusting the fibre weighting. The non-discriminated results are within the factor of two intra-laboratory precision target set for the PCM/PLM analysis).

Table 7: TEM results from dolomite sample 0 - 30 μm for untreated and acid washed sample preparation. (Sample No HSL/82167/95)

7a: Summary of fibre mass and percentage of total mass for all widths

Treatment and (Fibre dimensions sized)	Mass of all fibres(g) Dolomite+Tremolite	Mass of Tremolite(g) fibres.	Mass of Dolomite(g) fibres.
Untreated dolomite (fibres > 5μm long)	1.43×10^{-8} (0.81%)	1×10^{-8} (0.56%)	4.3×10^{-9} (0.24%)
Untreated dolomite (All lengths)	2.06×10^{-9} (0.45%)	N/A	N/A
Acid washed dolomite (fibres > 5μm long)	1.48×10^{-8} (6.2%)	1.48×10^{-8} (6.2%)	3.97×10^{-11} (0.02%)
Acid washed dolomite (All lengths)	1.51×10^{-8} (6.3%)	1.5×10^{-8} (6.3%)	1.42×10^{-10} (0.06%)

7b: Summary of fibre mass and percentage of total mass for all widths < 3 µm

Treatment and (Fibre dimensions sized)	Mass of all fibres (Dolomite+Tremolite). (g)	Mass of Tremolite fibres. (g)	Mass of Dolomite fibres. (g)
Untreated dolomite (fibres > 5µm long)	6.73×10^{-9} (0.38%)	4.51×10^{-9} (0.25%)	2.22×10^{-9} (0.13%)
Untreated dolomite (All lengths)	1.68×10^{-9} (0.37%)	N/A	N/A
Acid washed dolomite (fibres > 5µm long)	7.97×10^{-10} (0.33%)	7.57×10^{-10} (0.32%)	3.97×10^{-11} (0.02%)
Acid washed dolomite (All lengths)	1.1×10^{-9} (0.46%)	9.62×10^{-10} (0.4%)	1.42×10^{-10} (0.6%)

The mass data by fibre width for the same sample is given in fig 8 and table 8.

Fig 8: A graph of fibre width v mass for > 5 µm long tremolite fibres. Sample HSL/82761/95.

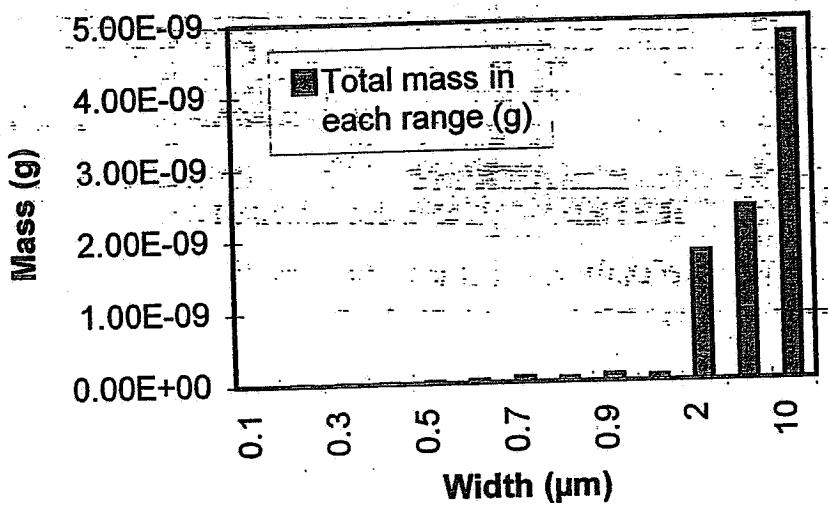


TABLE 8: Distribution of mass in terms of fibre width from the TEM analysis of the 0-30 µm dolomite sample

	Fibres of all lengths		Fibres >5µm long	
Diameter range (µm)	Total mass in each range (ng)	Percentage of mass in each width range (%)	Total mass in each range (ng)	Percentage of mass in each width range (%)
0 - 0.1	0	0.01	0	0.02
0.1 - 0.2	0.01	0.06	0.01	0.07
0.2 - 0.3	0.01	0.06	0.01	0.11
0.3 - 0.4	0	0.05	0.01	0.13
0.4 - 0.5	0.02	0.22	0.01	0.09
0.5 - 0.6	0.03	0.33	0.02	0.22
0.6 - 0.7	0.07	0.72	0.03	0.36
0.7- 0.8	0.05	0.54	0.03	0.3
0.8- 09	0.09	0.92	0.04	0.45
0.9 -1.0	0.07	0.75	0.05	0.5
1 - 2	1.78	19.14	0.36	3.87
2 - 3	2.39	25.7	0.4	4.35
3 -10	4.79	51.5	8.24	89.55
a)Mass <1µm	0.35	3.66	0.21	2.25
b)Mass <3µm	4.52	48.5	0.97	10.47
c)Total Mass	9.31	100	9.21	100.02
a/b		7.7		21.5
a/c		3.7		2.2

The TEM data show that the percentage mass of fibres below 1 µm width is low (3.7 and 2.25 % respectively) both for fibres of all lengths and >5 µm length. The figures for <3 µm width are 48.5 and 10.47% respectively. In terms of mass evaluation, the <1 µm width fibres can be ignored. For a precise measurement of mass the contribution of the largest fibres must be evaluated and in sufficient numbers to decrease the influence of any single fibre. Therefore low magnification scanning of

the entire filter fibre at x50 or x 100 would be the most appropriate mass evaluation strategy. Therefore the PCM/PLM method would seem to be the method of choice to assess fibre mass in this sample.

However, if the TEM asbestos width distribution is examined (fig. 9), it can be seen that over half the fibres have widths below the lower limit of visibility of the PCM (0.2 - 0.3 µm) and approximately 90% of the fibres widths are < 1.0 µm, below which identification is not possible by PLM. The TEM analysis therefore detected a substantial number of fine tremolite fibres. The finer fibres had the higher aspect ratios and were essentially asbestos fibres (see fig. 10 and plate 15). Conversely, the wider fibres had much lower aspect ratios and were not asbestos like. Figure 11 shows the aspect ratios have a long tail and is tending towards the aspect ratio distribution that is found for tremolite asbestos (fig 12). Also as no fibre had a width greater than 3µm and the width distribution had a mean of 0.2 um, the measured TEM fibre size distribution is typical of a ground asbestos sample.

Figure 9: Fibre width distribution for all fibres (HSL/82761/95)

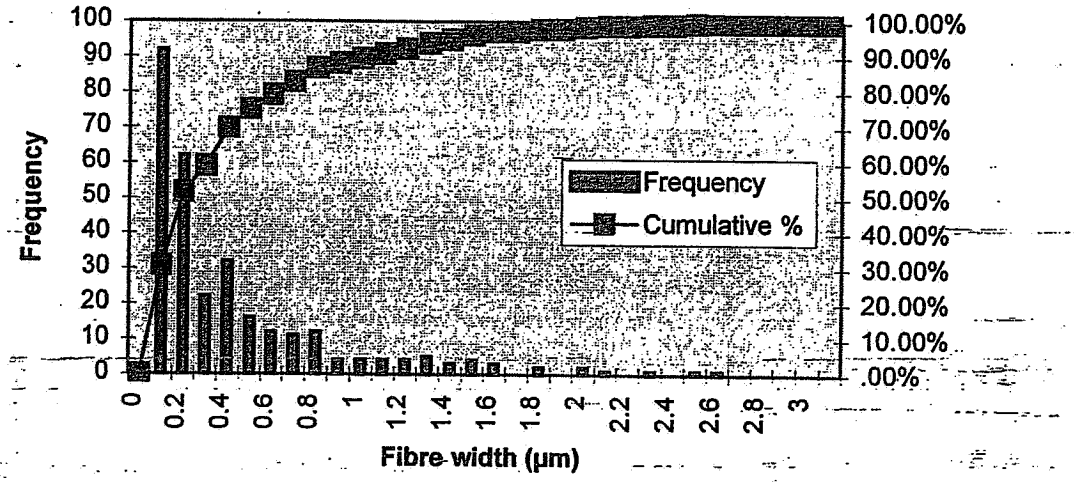
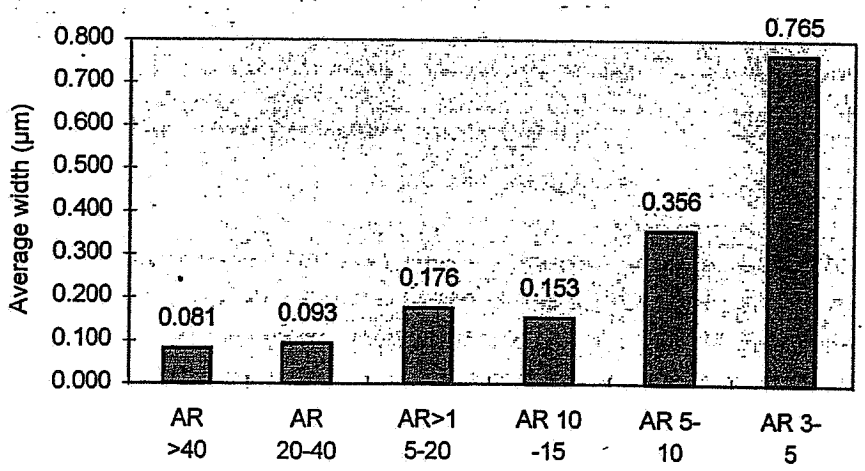


Figure 10: Average width of fibres v aspect ratio for all fibres (HSL/82761/95)



tremolite in dolomite (HSL/82761/95)

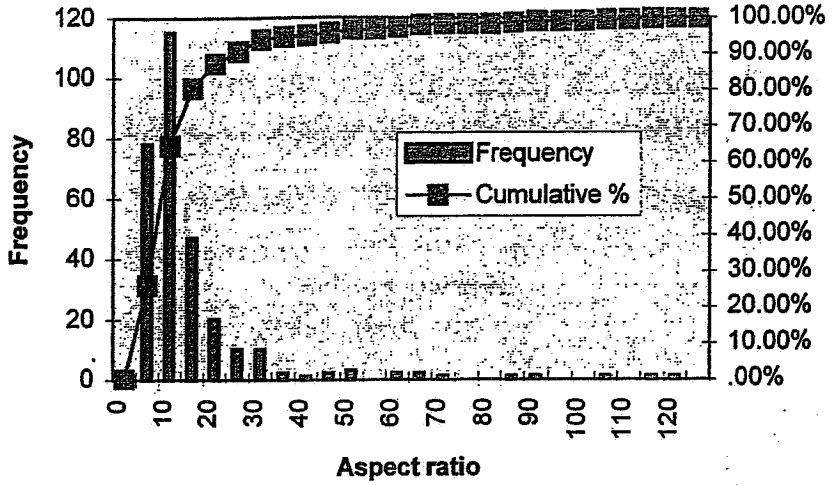
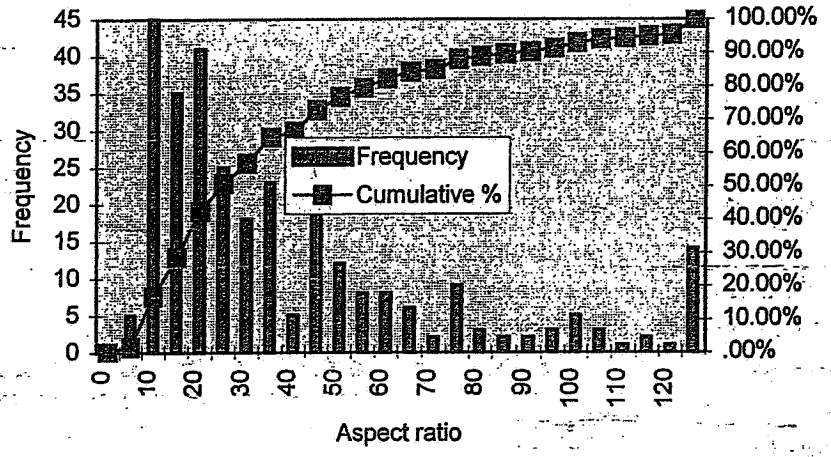


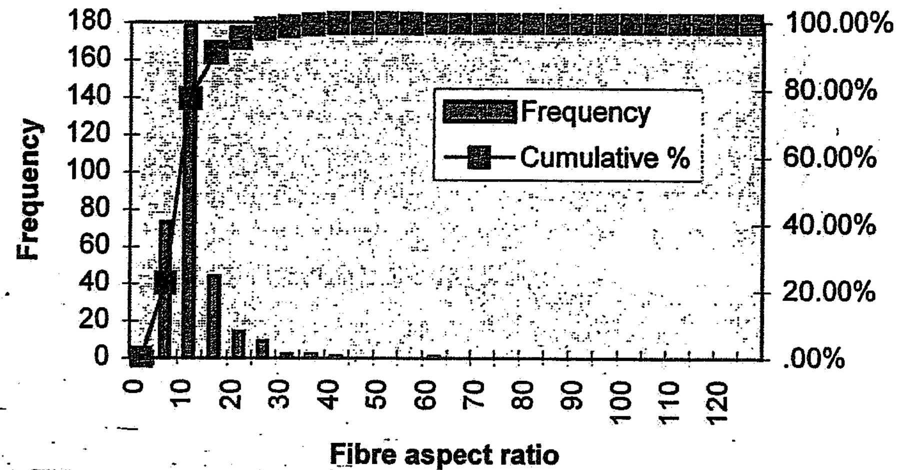
Figure 12: Aspect ratio distribution: all fibres >3:1
Jamestown tremolite (HSL/82077/95)



When the aspect ratio distributions of non-asbestos tremolite are compared (figure 13 and plate 6) it can be seen that the distribution is closer to that of cleavage fragments than asbestos fibres. Simple comparisons can be ambiguous. These results demonstrate that if percentage mass is to be the measurement of asbestos hazard in the EU, the PCM/PLM method which discriminates fibres >0.8µm wide, should be the method of choice. However, as seems likely in this case the mass that is evaluated will not be a measure of the mass of asbestos fibres, which have been largely reduced to sub-optical fibres by the grinding process. If the grinding process is reasonably efficient it could be argued that no >1 um asbestos fibres are left in the sample and the PCM/PLM estimate is based solely on the elongated mineral fragments. Applying this

reasoning to the dolomite sample with 1 um as the cut-off point, a maximum of 3.7 % of fibres of all lengths and 2.2% of fibres >5 um long could possibly be asbestos.

Figure 13: Tremolite (Edenitic) Drumnadrochit: all fibes >3:1 (HSL/83059/97)



6.2 Study of known asbestos containing samples

As seen above, the simplest way to decide whether a fibre population is asbestos or not is to compare it with a known asbestos population. This approach requires a detailed knowledge of : the sample's history, sampling method, sample preparation and analysis. For example, an airborne asbestos sample may have a reduced numbers of larger fibre widths compared to the bulk material through gravitational settlement. However, if the original sample is ground, it may be reduced to fibres which are almost entirely respirable. An optical microscope assessment of particle size preferentially selects large fibres and will give a very different from a TEM fibre size distribution. Even when using the same method: the magnification, degree of accuracy of the width measurement, the calibration of the instrument and the lower length cut-off, will all produce differences in the measured length, width and aspect ratio distributions. This makes it rather difficult to carry out comparison unless the sizing has been carried out using a standardised procedure.

6.2.1 Preparation and analysis of EU samples

A stock of well-characterised samples were produced for the EU study and coded as follows:

1. New York talc undiluted 20-40% tremolite and anthophyllite.
2. New York talc 1 dilution 1:10.
3. New York talc 2 dilution 1 :10.
4. Acid washed dolomite (contains tremolite asbestos).
5. Amosite in soil, spiked 1%.
6. Fibrous wollastonite (no asbestos).
7. Vermiculite with tremolite asbestos, spiked 0.05%.
8. Amosite as asbestos cement fragments in demolition waste, spiked 0.25%.
9. Chrysotile in olivine sand, spiked 0.01%.
10. Crocidolite in sepiolite, spiked 0.1 %.
11. Amosite in talc, spiked 0.15%.
12. Dolomite.

A number of sub-samples from the materials prepared were distributed to various EU laboratories for analysis by the EU PCM/PLM method.

6.2.2 *Light microscopy size analysis of asbestos by PCM/PLM.*

The EU bulk method uses a relatively crude sizing grid to size fibres into lengths of 5 μm increments and widths in 0.5 μm increments, with one increment of 0.25 - 0.5 μm for just visible fibres at X400 magnification by PCM. .A summary of the size distribution data for several of the round-robin are summarised in tables 9 -11.

It is clear from the data that only a small percentage of the fibres had widths greater than 1 μm with the percentage being largest for amosite (9.3%) and smallest for crocidolite (0.8%). Very few fibres (9 from 9587) had widths > 3 μm and 99.99% of the fibres counted were potentially respirable. The mean fibre lengths all lay between 10 -20 μm. With the exception of chrysotile which formed very high aspect ratio fibres, the median aspect ratio for amphibole asbestos was ≥20:1 and some 90% of fibres had aspect ratios ≥10:1. These data therefore provide some guidance as to what asbestos fibres should look like after following the EU PCM/PLM light microscope method. The aspect ratio distributions for the EU samples are plotted in figure 14. Interestingly the results from the New York talc sample (1,2, 3) were indistinguishable from the other types of asbestos.

Table 9: Fibre length distribution descriptive statistics for PCM/PLM sizing of the EU round robin samples.

Parameter	Bulk 5	Bulk 7	Bulk 8	Bulk 9	Bulk 10	Bulk 1.2.3
Mean	10.8	16.22	12.5	12.37	18.25	11.06
Standard Error	0.14	0.36	0.27	0.29	1.04	0.23
Median	10	10	10	10	15	10
Mode	5	10	5	5	10	5
Standard Deviation	8.91	13.33	10.09	10.81	15.48	8.18
Sample Variance	79.34	177.68	101.75	116.86	239.7	66.85
Kurtosis	13.64	5.43	10.97	12.37	2.97	4.72
Skewness	2.87	2	2.59	2.91	1.46	1.79
Range	100	95	95	95	90	60
Minimum	0	0	0	0	0	0
Maximum	100	95	95	95	90	60
Sum	43,692	22,551	17,779	16,943	4,015	13,707
Count	4,045	1,390	1,422	1,370	220	1,239

Table10: Fibre width distribution descriptive statistics for PCM/PLM Sizing

Parameter	Bulk 5	Bulk 7	Bulk 8	Bulk 9	Bulk 10	Bulk 1.2.3
Mean	0.64	0.52	0.79	0.55	0.43	0.5
Standard Error	0.01	0.01	0.01	0.03	0.01	0.01
Median	0.5	0.5	0.5	0.5	0.5	0.5
Mode	0.5	0.5	0.5	0.5	0.5	0.5
Standard Deviation	0.4	0.31	0.45	0.5	0.28	0.29
Sample Variance	0.16	0.1	0.2	0.25	0.08	0.08

Kurtosis	2.48	0.58	10.69	21.26	2.01	1.66
Skewness	1.04	0.69	1.93	3.74	0.89	0.75
Range	3	1.5	5	4	2	2
Minimum	0	0	0	0	0	0
Maximum	3	1.5	5	4	2	2
% > 1µm	5.5	1.8	9.3	4.5	0.8	1
% > 3µm	0	0	0.2	0.9	0	0
Count	4,045	1,422	1,370	220	1,390	1,239

Table 11: Fibre aspect ratio distribution descriptive statistics for PCM/PLM sizing

Parameter	5	7	8	9	10	123
Mean	33.07	49.34	27.13	75.82	99.22	44.58
Standard Error	0.75	1.93	1.33	6.42	4.49	1.91
Median	20	20	15	50	40	20
Mode	10	10	10	40	20	10
Standard Deviation	47.77	72.51	48.88	83.42	166.8	66.37
Sample Variance	2,282.12	5,258.02	2,389.16	6,958.37	27,823.32	4,405.53
Kurtosis	61.63	74.86	116.84	35.73	43.22	20.24
Skewness	5.75	6.26	8.87	4.98	5.38	3.86
Range	947.5	1,295	896.67	790	1,995	646.67
Minimum	2.5	5	3.33	10	5	3.33
Maximum	950	1,300	900	800	2,000	650
% ≤5:1	8.6	1.9	10.18	0	0.58	2.31
% ≤10:1	40.69	28.56	42.94	2.37	15.87	32.87
% ≤20:1	63.98	50.28	71.62	11.83	32.68	58.05
Count	4,045	1,422	1,370	220	1,390	1,239